

REMARKS

The claims remaining in the present application are Claims 1-3, 6, and 8-92.

Claims 1 and 11 have been amended. Claims 12-92 have been added. No new matter has been added as a result of these amendments.

NEW CLAIMS

New Claim 12 recites:

A method of controlling a computer processor, comprising:
monitoring operating conditions internal to a computer processor;
determining a frequency and a voltage at which to operate said
computer processor, based on said internal operating conditions; and
implementing the determined frequency and voltage.

Claim 12 recites “monitoring operating conditions internal to a computer processor.” Claim 12 further recites, “determining a frequency and a voltage at which to operate said computer processor, based on said internal operating conditions.” Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 12.

Horden et al., U.S. Patent No. 5,812,860 (hereinafter Horden) actually teaches away from using operating conditions internal to a computer processor,” as claimed. For example, Horden at col. 4, lines 42-44 teaches that a maximum power consumption level is established by user, the operating system, or some sort of external consideration. None of these are “operating conditions internal to a computer processor,” as claimed.

Moreover, Horden teaches a two voltage embodiment at col. 3, line 48, in which the operating system notifies the state machine whether the core should be operating at peak or idle frequencies and voltages. That is, the decision as to what voltage and frequency at which to operate is made by the operating system, based on considerations external to the processor. For example, the operating system identifies whether core utilization and the corresponding throughput can be handled at an idle frequency or if a higher frequency is needed (col. 3, lines 50-53). In contrast, Claim 12 recites, “monitoring operating conditions internal to a computer processor” and “determining a frequency and a voltage suitable for a level of power consumption, based on said operating conditions.”

Horden at col. 4, line 12 discloses an embodiment with more than two operating voltages. Horden states, “[i]n this embodiment, the operating system acquires some objective measure of processor need for each application (not shown) seeking access to the processor core which may or may be (sic) in MIPS, MFLOPS or another objective measure of processor need” (col. 4, lines 23-27). The operating system accumulates the processor need for all applications currently running. The operating system then directs the state machine to transition into a state that closely matches the frequency and voltage to the application mix currently accessed in the processor core. (col. 4, lines 32-37).

New Claim 20 recites:

A method of controlling a computer processor, comprising:
monitoring idle time of a computer processor;
determining a frequency and a voltage at which to operate said
computer processor, based on said idle time; and
implementing the determined frequency and voltage.

New Claim 20 recites “monitoring idle time of a computer processor.” For the reasons discussed in the discussion of New Claim 12, Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 20.

New Claim 29 recites:

A method of controlling a computer processor, comprising:
monitoring a state of a computer processor;
determining a frequency and a voltage at which to operate said
computer processor, based on said state; and
implementing the determined frequency and voltage.

New Claim 29 recites “monitoring a state of a computer processor.” For the reasons discussed in the discussion of New Claim 12, Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 29.

New Claim 40 recites:

A method of controlling a computer processor, comprising:
a) monitoring operating temperature of said computer processor;
b) based on said operating temperature, determining that said
computer processor can be operated at a higher frequency than a frequency
at which said computer processor is currently operating without exceeding a
threshold of said operating temperature; and
c) increasing a frequency at which said computer processor operates
above said current frequency.

New Claim 40 recites “monitoring operating temperature of a computer processor.” Claim 40 further recites, “based on said operating temperature, determining that said computer processor can be operated at a higher frequency without exceeding a threshold of said operating temperature.” Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 40.

New Claim 46 recites:

A method of controlling a computer processor, comprising:
a) monitoring operating temperature of said computer processor;
b) based on said operating temperature, determining that a voltage at which said computer processor operates can be increased without exceeding a threshold of said operating temperature; and
c) increasing voltage at which said computer processor operates.

New Claim 46 recites “monitoring operating temperature of a computer processor.”

Claim 46 further recites, “based on said operating temperature, determining that a voltage at which a computer processor operates can be increased without exceeding a threshold of said operating temperature.” Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 46.

New Claim 48 recites:

A method of managing power consumption comprising:
monitoring internal conditions of a computer processor;
based on said internal conditions, determining an allowable power consumption level;
determining a voltage-frequency pair for said allowable power consumption level; and
dynamically changing power consumption of the computer processor by implementing said voltage-frequency pair.

New Claim 48 recites “monitoring internal conditions of a computer processor.”

Claim 48 further recites, “based on said internal conditions, determining an allowable power consumption level.” Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 36. For example, Horden at col. 4, lines 42-44 teaches that a maximum power consumption level is established by user, the operating system, or some sort of external consideration. None of these are “operating conditions internal to a computer processor,” as claimed.

New Claim 67 recites:

A method of controlling a processor, comprising:
monitoring operating temperature of a computer processor; and
in response to said operating temperature crossing a threshold,
dynamically adjusting a frequency and a voltage at which said computer
processor operates to a pre-determined frequency-voltage pair.

Applicants respectfully assert that the cited art fails to teach or suggest the
limitations of Claim 67.

New Claim 76 recites:

A computing device comprising:
a power supply furnishing selectable output voltages;
a clock frequency source; and
a central processor comprising:
a clock frequency generator receiving a clock frequency
from the clock frequency source; and
a processing unit operable to provide values indicative of
operating conditions of the central processor and to cause the
power supply and the clock frequency generator to furnish a
voltage level and an output clock frequency for the central
processor.

Applicants respectfully assert that the cited art fails to teach or suggest the
limitations of Claim 76.

New Claim 89 recites:

A method of operating a computer processor comprising an input
voltage, an input frequency and an operating temperature, said method
comprising:
operating said computer processor with said operating temperature
below a pre-selected temperature with said input voltage at a safe voltage level
and said input frequency at a safe frequency;
increasing said input voltage to a level higher than said safe voltage
level;
increasing said input frequency to a level higher than said safe
frequency; and

executing processor-intensive commands while said input voltage is at a level higher than said safe voltage level and said input frequency is at a level higher than said safe frequency.

New Claim 89 recites "increasing said input voltage to a level higher than said safe voltage level." Claim 89 further recites, "increasing said input frequency to a level higher than said safe frequency." Applicants respectfully assert that the cited art fails to teach or suggest the limitations of Claim 89.

Claims 13-19, 21-28, 30-39, 41-45, 47, 49-66, 68-75, 77-79, and 90-92 depend from New Claims 12, 20, 29, 40, 46, 48, 67, 76, and 89 which are believed to be allowable for the foregoing rationale. As such, Claims 13-19, 21-28, 30-39, 41-45, 47, 49-66, 68-75, 77-79, and 90-92 are believed to be allowable and their allowance is earnestly solicited.

CLAIM REJECTIONS

35 U.S.C. §103

Claims 1-3, 6, and 8-11 are rejected under 35 U.S.C. §103 as being unpatentable over Horden et al U.S. Pat. No. 5,812,860 in view of Weiss et al., U.S. Pat. No. 5,774,703 (hereinafter Weiss). The rejection is respectfully traversed. Neither Horden nor Weiss, alone or in combination, teach or suggest the limitations of Claims 1-3, 6, and 8-11.

Claim 1

Currently Amended Claim 1 recites:

A method for controlling power consumption of a computer processor on a chip comprising the steps of:

determining a maximum allowable power consumption level from an operating condition of the processor,
determining a maximum frequency which provides power not greater than the allowable power consumption level,
determining a minimum voltage which allows operation at the maximum frequency determined, and
dynamically changing the power consumption of the processor by changing frequency and voltage, respectively, to the maximum frequency and the minimum voltage determined.

Currently amended Claim 1 recites that a maximum allowable power consumption level is determined from the operating condition of the processor. Applicants respectfully assert that neither Horden nor Weiss, alone or in combination, teach or suggest, “determining a maximum allowable power consumption level from the operating condition of the processor,” as claimed.

For the reasons discussed in the discussion of New Claim 12, Horden fails to teach or suggest, “determining a maximum allowable power consumption level from the operating condition of the processor,” as claimed. For example, Horden at col. 4, lines 42-44 teaches that a maximum power consumption level is established by user, the operating system, or some sort of external consideration.. Horden discloses that, “the operating system acquires some objective measure of processor need for each application (not shown) seeking access to the processor core which may or may be (sic) in MIPS, MFLOPS or another objective measure of processor need” (col. 4, lines 23-27). The operating system accumulates the processor need for all applications currently running. The operating system then directs the state machine to transition into a state that closely matches the frequency and voltage to the application mix currently accessed in the processor core. (col. 4, lines 32-37). Thus, Horden fails to teach or suggest, “determining a

maximum allowable power consumption level from the operating condition of the processor." as claimed.

Weiss fails to remedy this deficiency in Horden. For example, Weiss teaches a system having a register controllable processor speed (Abstract). However, Weiss does not deal with determining a maximum allowable power consumption level from the operating condition of the processor, as claimed. Weiss teaches several sets of registers for adjusting frequency. First, Applicants do not understand Weiss to teach adjusting the voltage at which a processor operates. Applicants note that the registers in Weiss are for adjusting frequency, and any change to power opposed is incidental. Second, Applicants note that the registers are not based on operating condition of the processor. A first set of registers specifies the desired clock speed for various interrupts (col. 3, lines 38-40). A second set of registers allows the frequency to be based on software needs. Weiss teaches that a programmer can allocate a slower speed for tasks that can be executed successfully at lower speeds (col. 3, lines 51-55). A third set of registers correspond to different subsystems sections or components (col. 3, lines 65-66), which are independently programmed and timed separately from each other. None of these three sets of registers determines a maximum allowable power consumption level from the operating condition of the processor, as claimed. Rather, the registers allow a frequency adjustment based on factors such as what code is being executed or what subsystems are affected, as opposed to operating condition of the processor.

For the foregoing rationale, it is respectfully submitted that Claim 1 is not obvious over Horden in view of Weiss. As such, allowance of Claim 1 is respectfully solicited.

Claim 2

Claim 2 recites, in part:

a processing unit for providing values indicative of operating conditions of the central processor...
means for detecting the values indicative of operating conditions of the central processor and causing the power supply and clock frequency generator to furnish an output clock frequency and voltage level for the central processor.

For the rationale presented in the response to Claim 1, Claim 2 is not obvious over Horden in view of Weiss. As such, allowance of Claim 2 is respectfully submitted.

Claim 6

Claim 6 recites:

A method for controlling the power used by a computer comprising the steps of:
utilizing control software to measure the operating characteristics of a central processor of the computer,
determining when the operating characteristics of the central processor are significantly different than required by the operations being conducted, and
changing the operating characteristics of the central processor to a level commensurate with the operations being conducted in which:
the step of determining when the operating characteristics of the central processor are significantly different than required by the operations being conducted comprising utilizing the control software to determine desirable voltages and frequencies for the operation of the central processor based on the measured operating characteristics, and
the step of changing the operating characteristics of the central processor to a level commensurate with the operations being conducted comprises providing signals:
for controlling voltages furnished by a programmable power supply to the central processor,

for controlling frequencies furnished by the central processor to the central processor, and providing signals for controlling frequencies furnished by the central processor to other functional units of the computer (emphasis added).

Claim 6 recites that control software is used to measure operating characteristics of a central processor of the computer. In contrast, Horden teaches that applications may be modified to tell the operating system what their respective needs are (col. 4, lines 26-29). However, Horden does not teach or suggest an application program measuring the operating characteristics of a central processor of the computer, as claimed. Weiss fails to remedy this deficiency in Horden. Thus, neither Horden nor Weiss teach or suggest, alone or in combination, control software used to measure operating characteristics of a central processor of the computer, as claimed. In addition, for the rationale presented in the response to Claim 1, Claim 6 is not obvious over Horden in view of Weiss. As such, allowance of Claim 6 is respectfully submitted.

Claim 8

Claim 8 recites, in part:

a processing unit for providing values indicative of operating conditions of the central processor

For the rationale presented in the response to Claim 1, Claim 8 is not obvious over Horden in view of Weiss. As such, allowance of Claim 8 is respectfully submitted.

Claims 3 and 9-11

Claim 3 depends from Claim 2, which is believed to be allowable for the discussed rationale. As such, allowance of Claim 3 is respectfully solicited. Claim 11 has been amended to clarify that the word "including" is intended to be cancelled without prejudice, if such an amendment was not previously entered. Claims 9-11 depend from Claim 8, which is believed to be allowable for the discussed rationale. As such, allowance of Claims 9-11 is respectfully solicited.

New Claims 80-88

New Claims 80-88 depend from Claim 1, which is believed to be allowable for the foregoing rationale. As such, Claims 80-88 are believed to be allowable and their allowance is earnestly solicited.


CONCLUSION

In light of the above listed amendments and remarks, reconsideration of the rejected Claims is requested. Based on the arguments and amendments presented above, it is respectfully submitted that Claims 1-3, 6 and 8-92 overcome the rejections of record and, therefore, allowance of Claims 1-3, 6 and 8-92 is earnestly solicited.

Should the Examiner have a question regarding the instant response, the Applicants invite the Examiner to contact the Applicants' undersigned representative at the below listed telephone number.

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Respectfully submitted,
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